

# Appendix K

## Strategic Flood Risk Assessment



**Straitéis Iompair na Gaillimhe**  
**Galway Transport Strategy**

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***Galway Transport Strategy  
Strategic Flood Risk Assessment***

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**Report No. HEL204504\_v1.1**

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**Galway City Council**

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**29<sup>th</sup> August 2016**



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**Hydrological & Environmental  
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# Strategic Flood Risk Assessment Of the Galway Transport Strategy Project



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Appendix A – Figures of GTS Measures with PFRA and CFRAM Mapping

## 1. INTRODUCTION

Hydro Environmental Ltd in association with Arup was by appointed by Galway City Council and Galway County Council in partnership with the National Transport Authority to carry out a Strategic Flood Risk Assessment (SFRA) for the Galway Transport Strategy (GTS).

It was determined by Galway City Council that a Strategic Flood Risk Assessment (SFRA) is required in order to assess and manage flood risk in accordance with the Office of Public Works (OPW) Flood Risk Management Planning Guidelines (FRMPG). This document presents the current findings of the SFRA of the GTS. The purpose of this document is to detail the findings of the Stage 2 SFRA.

The SFRA has been undertaken in accordance with *The Planning System and Flood Risk Management – Guidelines for Planning Authorities (Dept. of the Environment, Heritage and Local Government and The Office of Public Works, Nov 2009)*.

Chapter 2 of this report outlines the flood risk management policies and guidelines used for this assessment. Chapter 3 includes an overview of the Galway City Transport Strategy and the measures which are assessed. Finally Chapter 4 documents the Stage 1 Flood Risk Identification, and then follows with Stage 2 Initial Flood Risk Assessment of these identified locations and finally recommends where Stage 3 Detailed Flood Risk Assessment will be required.

Figures with the GTS measures overlaid on PFRA and CFRAM mapping are included in Appendix A of this report. Figure GCOB-SK-D-677 includes pluvial and groundwater indicative flooding, GCOB-SK-D-678 includes coastal and fluvial indicative flooding and GCOB-SK-D-683 to 685 includes CFRAM Flood Risk Mapping.

## **2 FLOOD RISK MANAGEMENT POLICY**

### **2.1 EU Floods Directive**

The European Floods Directive 2007/60/EC on the assessment and management of flood risk aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. This directive applies to both inland waters and coastal waters across the whole territory of the EU.

The directive requires all member states to undertake a national preliminary flood risk assessment in order to identify areas where significant flood risk exists or might be considered likely to occur and to prepare flood hazard and flood risk maps for such areas by December 2013. The Directive requires the preparation of catchment-based Flood Risk Management Plans (FRMPs) by 2015, which will set out flood risk management objectives, actions and measures. These Flood Risk Management Plans are to include measures to reduce the probability of flooding and its potential consequences. Implementation of the EU Floods Directive is required to be coordinated with the requirements of the EU Water Framework Directive and current River Basin Management Plans.

### **2.2 National Flood Policy review**

#### **2.2.1 Background**

Historically management of flooding was implemented by drainage commissioners and focused on the protection and improvement of land for agricultural purposes and this is reflected in the various Drainage Acts passed (1842, 1867, 1925, 1928, and 1945).

The Brown Commission (Report of the Drainage Commission 1938-1940) which examined flooding and improvement of land through drainage resulted in the development of the Arterial Drainage Act, 1945. The Brown Commission recommended the establishment of a single national drainage authority with a remit to embark on a national drainage programme. The Office of Public Works (OPW) became the Statutory Authority responsible for implementing arterial drainage schemes nationally.

The emphasis of the 1945 act was improvement of agricultural land and following the act a priority list of river basins was set out and a programme of drainage works commenced and continued up until the early 1990's. This drainage act was amended in 1995 to allow the OPW to implement localised flood relief schemes for relieving flooding in urban areas. This amendment recognised that urban flooding had become

a significant problem and signalled a departure away from arterial drainage of lands with no new arterial drainage schemes being implemented.

The various drainage districts and arterial drainage schemes, local flood relief schemes carried out under the drainage act continue to be maintained today by the OPW and Local Authorities.

### **2.2.2 Report of the Flood Policy Review Group**

In 2003 a review of the National Flood Policy was carried out by a review group of relevant stakeholders. The review focuses on fluvial (river) and tidal flooding and concentrates on the roles of the state agencies in these areas. The scope of the review included the following:

- Causes, extent and impacts of the flooding problem
- Current roles and responsibilities of the main state bodies
- International best practice
- Future flood policy
- Proposals for future organisational structures and responsibilities
- Resource requirements and strategic programme

The review group prepared a report by December 2003 that was approved by government and published in September 2004. The adopted policy has many specific recommendations, including:

- Minimise the national level of exposure to flood damages through identification and management and future flood risks in an integrated, proactive and river basin based approach
- The Office of Public Works is to be the lead agency in delivering this policy
- All future expenditure in the area of flood relief will need to satisfy strict prioritisation criteria
- A two-pronged approach to flood management is to be pursued with a greater level of importance attributed to non-structural flood relief measures supported where necessary by traditional structural flood relief measures
- River basin flood management plans to be developed along with comprehensive Flood Hazard Maps and all information made available to

the Dept. of the Environment, Heritage and Local Government to inform future planning and development processes

- Programmes of necessary hydrological research were identified and included the update of the Flood Studies Report and river basin (hydrological) modelling, analysis of potential impact of climate change on flood frequency and severity and Meteorological forecasting

## **2.3 National CFRAM**

The OPW is the lead agency for flood risk management and part of its responsibility is the coordination and implementation of Government Policy on the management of flood risk in Ireland. The SI No. 122 on the European Communities (Assessment and Management of Flood Risks) 2010 identifies the Commissioners of Public Works as the competent authority with overall responsibility for the implementation of the Floods Directive (2007/60/EC).

In order to comply with the Floods Directive (2007) and the National Flood Policy Review Group (2004) a national Catchment Flood Risk Assessment and Management (CFRAM) programme commenced in 2011 and flood risk and hazard mapping completed in 2015 and the catchment management plans and the Strategic Environmental Assessment (SEA) process completed in 2016. This followed preparatory studies involving the Preliminary Flood Risk Assessment mapping and AFA (areas for further assessment) identification and followed a number of Pilot Catchment studies including the Lee Catchment FRAMS (commenced 2006), the River Dodder FRAMS (commenced 2007) and the Fingal East Meath FRAMS (commenced 2008) to refine the approach and methodologies to be adopted. The areas deemed to be at significant risk are identified as AFAs and more detailed assessment on the extent and degree of flooding was under taken in the CFRAM studies and involved detailed survey hydrological and hydraulic modelling, flood mapping, flood risk management plans and supporting Strategic Environmental Assessments.

## **2.4 Planning Guidelines Concerning Flood Risk Management**

### **2.4.1 Background**

In November 2009, the OPW and DoEHLG jointly published the Planning System and Flood Risk Management - Guidelines for Planning Authorities which are aimed at ensuring a more consistent, rigorous and systematic approach to fully incorporate flood risk assessment and management into the planning system.

The core objectives set out in these guidelines are to:

- Avoid inappropriate development in areas of flood risk

- Avoid new developments that may increase flood risk elsewhere
- Ensure effective management of residual risks for developments permitted in floodplains
- Avoid unnecessary restriction of national, regional or local economic growth
- Improve the understanding of flood risk among the relevant stakeholders
- Ensure that the requirements of EU and National law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.

The key principles to be adopted by regional and local authorities, developers and their agents are to:

- Avoid the risk, where possible
- Substitute less vulnerable uses, where avoidance is not possible
- Justify that the need for the development is a strategic need, where avoidance and substitution are not possible
- Mitigate and manage the risk

#### Decision Making Process

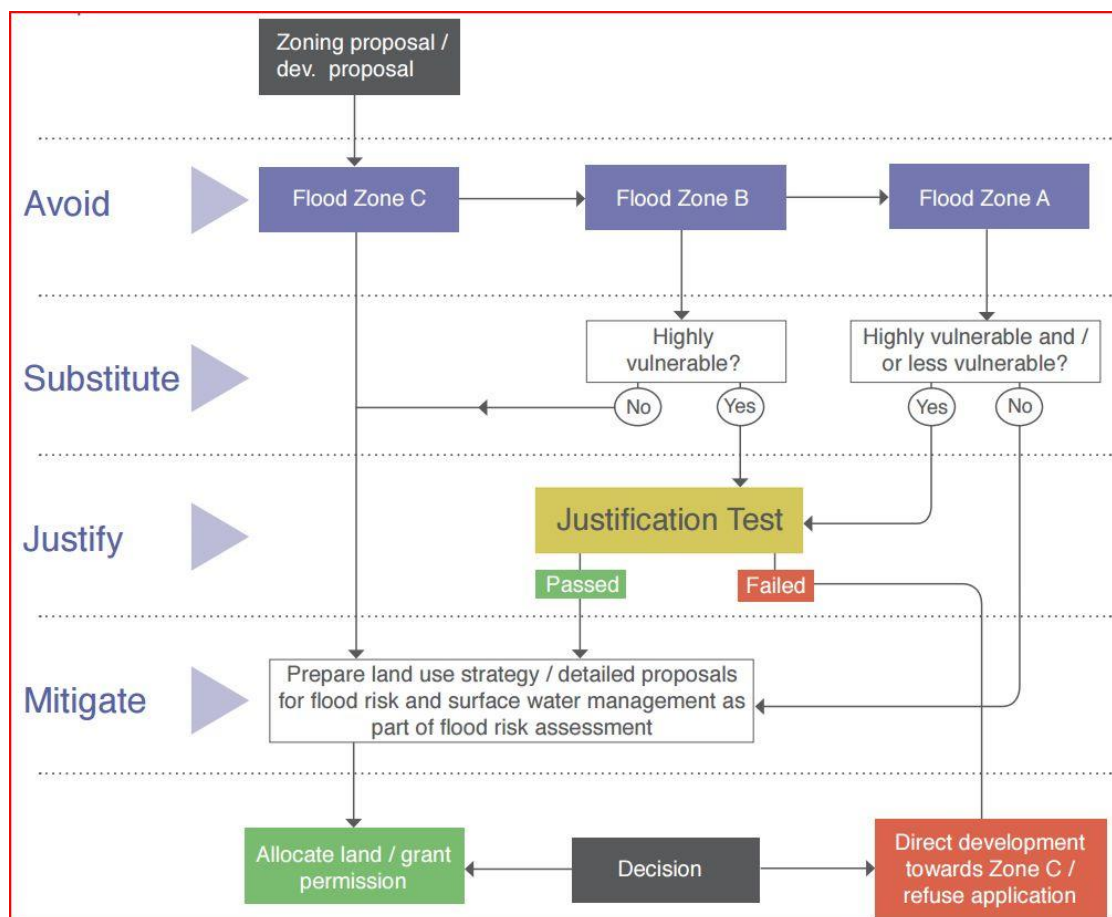
Management of flood hazard and potential risks in the planning system is based on:

1. Sequential Approach
2. Justification Test

#### **2.4.2 Sequential Approach**

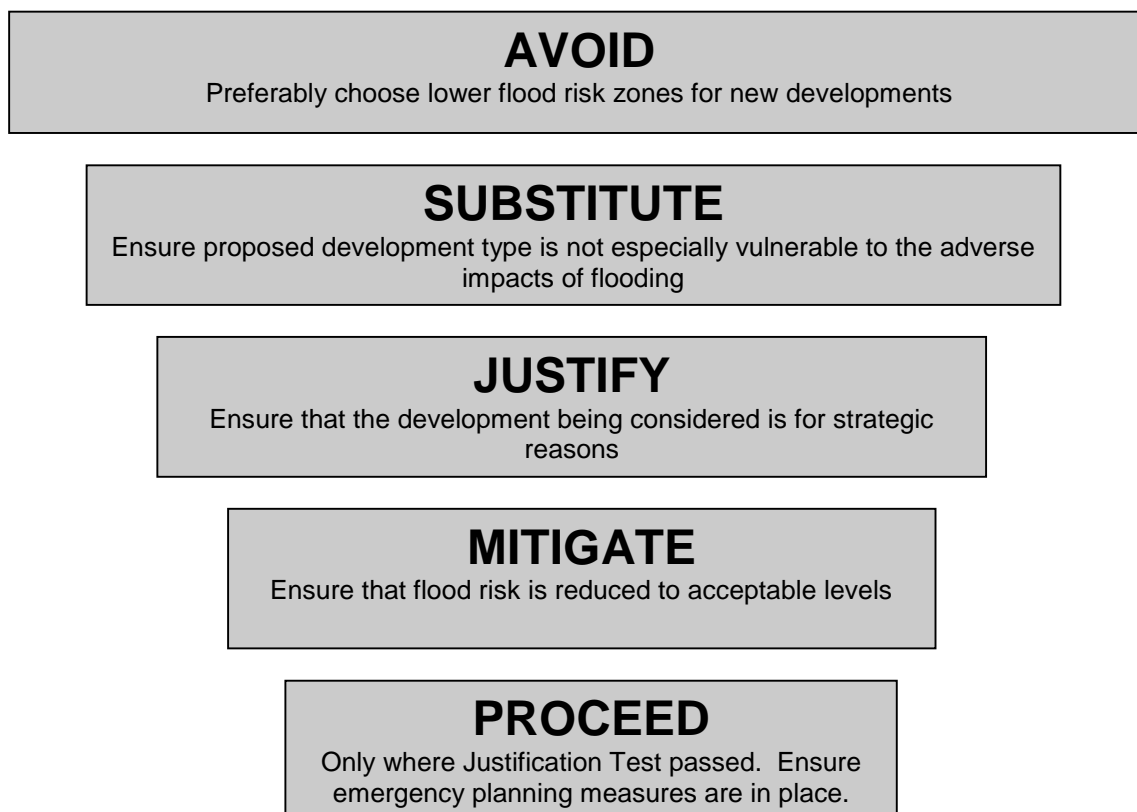
The aim of the sequential approach is to guide new development away from areas at risk from flooding into areas at low risk of flooding. The approach makes use of flood risk zones and classifications of vulnerability of property to flooding but ignores the presence of flood protection structures. The sequential approach should be applied to all stages of the planning process, particularly at the plan making stage.





**Figure 1 Sequential approach mechanism in the planning process (Fig. 3.2 from the Flood Risk Management Planning Guidelines)**

The Sequential Approach is based on the following principles:



### **2.4.3 Flood Risk Zones**

Definitions of flood risk zones in the planning guidelines are based on probability of occurrence with three flood risk zones (High, Moderate and Low) defined. These flood zones are as follows:

- Zone A High Probability – Highest risk of flooding: More than 1% probability of river flooding and more than 0.5% probability of tidal flooding. Development should be avoided and/or only considered through application of a justification test. Most types of development would be considered inappropriate in this zone. Development in this zone should be avoided and/or only considered in exceptional circumstances, such as in city and town centres, or in the case of essential infrastructure that cannot be located elsewhere, and where the justification test has been applied.
- Zone B Moderate Probability: Between 1 and 0.1% probability of river flooding or between 0.5 and 0.1% probability of coast flooding. Development should only be considered in this zone if adequate land or sites are not available in Zone C or if development in this zone would pass the Justification Test. Highly vulnerable development would generally be considered inappropriate in this zone, unless the requirements of the Justification Test can be met. Less vulnerable development and water-compatible development might be considered appropriate in this zone. In general however, less vulnerable development should only be considered in this zone if adequate lands or sites are not available in Zone C and subject to a flood risk assessment to the appropriate level of detail to demonstrate that flood risk to and from the development can or will adequately be managed.
- Zone C Low Probability: Less than 0.1% probability of river or coastal flooding. Development in this zone is appropriate from a flood risk perspective (subject to assessment of flood hazard from sources other than rivers and the coast) but would need to meet the normal range of other proper planning and sustainable development considerations.

These flood zones are determined on the basis of the probability of river and coastal flooding only and should be prepared by suitably qualified experts with hydrological experience. The derivation of these zones is broadly in line with those in common usage internationally. They are based on the current assessment of the 1% and the 0.1% fluvial events and the 0.5% and 0.1% tidal events, without the inclusion of climate change factors.

The provision of flood protection measures in appropriate locations, such as in or adjacent to town centres, can significantly reduce flood risk. However, the presence of flood protection structures should be ignored in determining the flood zones. This

is because areas protected by flood defences still carry a residual risk of flooding from overtopping or breach of the defences and the fact that there may be no guarantee that the defences will be maintained in perpetuity. The likelihood and extent of this residual risk needs to be considered, together with the potential impact on proposed uses, at both development plan and development management stages, as well as in emergency planning. In particular, the finished floor levels within protected zones will need to take account of both urban design considerations and the residual risk remaining.

#### **2.4.4 Development Type Vulnerability Classification**

In determining the suitability of the Development within the various flood zones the vulnerability class of the development is taken into consideration. Three categories of vulnerability are considered as described in Table 1 and 2 below:

**Table 1 Classification of Vulnerability of Different Types of Development**

<b>Vulnerability Class</b>	<b>Land uses and types of development which include*:</b>
Highly Vulnerable development (including essential infrastructure)	<ul style="list-style-type: none"> <li>• Garda, ambulance and fire stations and command centres required to be operational during flooding</li> <li>• Hospitals</li> <li>• Emergency access and egress points</li> <li>• Schools;</li> <li>• Dwelling houses, student halls of residence and hostels</li> <li>• Residential institutions such as residential care homes, children's homes and social services homes</li> <li>• Caravans and mobile home parks</li> <li>• Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility</li> <li>• Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding</li> </ul>
Less Vulnerable development	<ul style="list-style-type: none"> <li>• Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions</li> <li>• Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans</li> <li>• Land and buildings used for agriculture and forestry</li> <li>• Waste treatment (except landfill and hazardous waste)</li> <li>• Mineral working and processing</li> <li>• Local transport infrastructure</li> </ul>

<b>Vulnerability Class</b>	<b>Land uses and types of development which include*:</b>
Water Compatible development	<ul style="list-style-type: none"> <li>• Flood control infrastructure</li> <li>• Docks, marinas and wharves</li> <li>• Navigation facilities</li> <li>• Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation)</li> <li>• Lifeguard and coastguard stations</li> <li>• Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms</li> <li>• Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan)</li> </ul>
	<ul style="list-style-type: none"> <li>• Uses not listed here should be considered on their own merits</li> </ul>

**Table 2 Requirement for Justification Test based on Vulnerability group and Flood Zone Category**

<b>Vulnerability Class</b>	<b>Flood Zone A</b>	<b>Flood Zone B</b>	<b>Flood Zone C</b>
Highly Vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less Vulnerable development	Justification Test	Appropriate	Appropriate
Water Compatible development	Appropriate	Appropriate	Appropriate

#### **2.4.5 Justification Test**

Further sequentially based decision making should be applied when undertaking the Justification Test for development that needs to be in flood risk areas for reasons of proper planning and sustainable development:

- 1 within zone or site, development should be directed to areas of lower flood probability
- 2 where impact of the development on adjacent lands is considered unacceptable the justification of the proposal or zone should be reviewed

- 3 where the impacts are acceptable or manageable, appropriate mitigation measures within the site and if necessary elsewhere should be considered.

A justification test is required where a planning authority is considering the future development of areas at a high or moderate risk of flooding, for uses or development vulnerable to flooding that would generally be inappropriate as set out above within the flood zones. In such cases the planning authority must be satisfied that it can clearly demonstrate on a solid evidence base that the zoning or designation for development will satisfy the justification test outline in Box 4.1 of the guidelines as presented below in Plate 1.

#### Box 4.1: Justification Test for development plans

Where, as part of the preparation and adoption or variation and amendment of a development/local area plan<sup>1</sup>, a planning authority is considering the future development of areas in an urban settlement that are at moderate or high risk of flooding, for uses or development vulnerable to flooding that would generally be inappropriate as set out in Table 3.2, all of the following criteria must be satisfied:

- 1 The urban settlement is targeted for growth under the National Spatial Strategy, regional planning guidelines, statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.
- 2 The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and, in particular:
  - (i) Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement<sup>2</sup>;
  - (ii) Comprises significant previously developed and/or under-utilised lands;
  - (iii) Is within or adjoining the core<sup>3</sup> of an established or designated urban settlement;
  - (iv) Will be essential in achieving compact and sustainable urban growth; and
  - (v) There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.
- 3 A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere.

N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment.

#### Plate 1 Justification Test for development plans



#### **2.4.6 Strategic Flood Risk Assessment**

A staged approach to flood risk assessment that covers both the likelihood of flooding and the potential consequences is recommended in carrying out a Strategic Flood Risk Assessment (SFRA). The stages of appraisal and assessment are:

Stage 1 Flood Risk Identification

Stage 2 Initial Flood Risk Assessment

Stage 3 Detailed Flood Risk Assessment

*Stage 1 Flood risk identification* – to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and local area plans (LAPs) or a proposed development site that may warrant further investigation at the appropriate lower level plan or planning application levels.

*Stage 2 Initial flood risk assessment* – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped.

*Stage 3 Detailed flood risk assessment* – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

All stages may not be needed in the SFRA in order to inform the decision making process and often a Stage 2 assessment is sufficient at the strategic level to inform the decision making process. This will depend on the level of risk, the level of conflict with the proposed development and the scale of mitigation measure being proposed. For the purposes of applying the sequential approach, once a flood risk has been identified it can be avoided. Where development is planned in flood risk areas, a detailed assessment may be carried out within the SFRA, so that the potential for development of the lands and their environmental impact can be assessed.

A SFRA is individually designed to match the availability of data, scale and nature of the flood risk issues, the type of development and any focus on regeneration. The SFRA should provide sufficient information to make sound planning decisions,

including an identification and assessment of the impacts and mitigation strategies for development options.

The stage 1 SFRA of the Galway Transport Strategy will:

- Identify the broad nature of flood risk (type and source) within the study area
- Outline the flood risk management objectives to be included in the strategy
- Outline development management standards to be included in the strategy

The Stage 2 SFRA of the Galway Transport Strategy will:

- Provide an improved understanding of flood risk issues within the area of the transport strategy
- Provide more detailed assessment and management strategy for the transport infrastructure within the identified flood risk areas

Chapter 4 of this report describes the methodology of the stage 1 and 2 assessments and documents the findings of the SFRA for the GTS.

### 3. GALWAY TRANSPORT STRATEGY OVERVIEW

#### 3.1 Introduction

The Galway Transport Strategy examines the transportation issues facing Galway City and surrounding areas at present, and aims to underpin future growth by establishing a long-term strategy for transport to, within and around the city. The GTS will facilitate Galway with an opportunity to grow both physically and economically, offering better transport choices and creating a public realm to be enjoyed by residents and visitors alike. This transport strategy will in turn underpin the objectives of the current and future Galway City and County Development Plans.

The overall vision is:

*“to create a connected city region driven by smarter mobility.”*

To address the current and future transport needs of the city, it is concluded in the strategy that a fundamental shift is needed towards sustainable travel, reducing the dependency on the private car and taking action to make Galway City and its environs more accessible and connected, enhancing quality of life within the city for all. In order to achieve this vision the guiding principles underpinning the development of the Galway Transport Strategy are as follows:

- To promote and encourage sustainable transport, and in particular to make it convenient and attractive to walk, cycle or use public transport
- To improve accessibility and permeability to and within the city centre for pedestrians, cyclists and public transport users, while also maintaining an appropriate level of access for vehicular traffic for commercial and retail purposes
- To maximise the safety and security of pedestrians, cyclists and other transport users, particularly within the core city centre
- To manage and increase transport capacity, where necessary, for the efficient movement of people and goods into and within the city
- To provide opportunities to enhance the city centre Public Realm through traffic management and transport interventions
- To maintain and develop transport infrastructure and services to a high degree of quality and resilience
- To adopt a ‘smarter technology’ approach to all transport interventions, whereby transport infrastructure and services are future-proofed

The Galway Transport Strategy considers all transport modes, including but not limited to public transport, smarter mobility, cycling, walking, and road/street infrastructure. It assesses each in turn to establish its viability and suitability for a particular transport

demand. It also includes assessment of transport linkages between the city and surrounding settlements. The various projects that are proposed to be implemented through the GTS can be grouped under the following headings:

- the pedestrian network
- the cycle network which includes the Bearna Greenway, the Galway to Dublin Cycleway (Galway City to Oranmore)<sup>1</sup>, the Galway to Oughterard Greenway<sup>2</sup> and non-greenway elements
- the public transport network including increased frequency of buses and a new cross city access link
- the road network which includes the N6 Galway City Ring Road (GCRR) and modifications to the existing road infrastructure

### 3.2 Pedestrian Network

The proposed strategy provides for pedestrian priority within the city centre. A proposed cross-city link initiative will seek to reinforce the pedestrian at the top of the hierarchy of transport modes and underpin the planned transformation of the city centre. The limited number of crossings of the River Corrib within the city centre has been identified as a barrier to walking, in particular the poor quality pedestrian facilities at the bridges which are compounded by the heavy traffic flow across these bridges. It is proposed to provide a new pedestrian bridge crossing of the River Corrib downstream of the Salmon Weir Bridge and thereby remove pedestrians from the Salmon Weir Bridge. Other supporting measures for walking include an upgrade of road junction layouts and where appropriate provision of dedicated pedestrian crossings, provision of permeable pedestrian environments in residential areas, review of speed limits in the core city centre, removal of unnecessary street clutter to facilitate ease of movement along streets and the implementation of the Greenway Network, including the Bearna Greenway, the Galway to Dublin Cycleway (Galway City to Oranmore)<sup>3</sup>, the Galway to Oughterard Greenway<sup>4</sup> (the extension of the Dangan Greenway to Oughterard via Maigh Cuilinn) so as to enhance leisure walking facilities. In terms of flood vulnerability the primary pedestrian routes within the city centre would be considered to be “less vulnerable development” and the amenity / greenway routes to be “water compatible development”.

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<sup>1</sup> The GTS includes that portion of the Galway to Dublin Cycleway between Galway City and Oranmore.

<sup>2</sup> The GTS includes that portion of the Galway to Oughterard Greenway between Galway City and Moycullen.

<sup>3</sup> The GTS includes that portion of the Galway to Dublin Cycleway between Galway City and Oranmore.

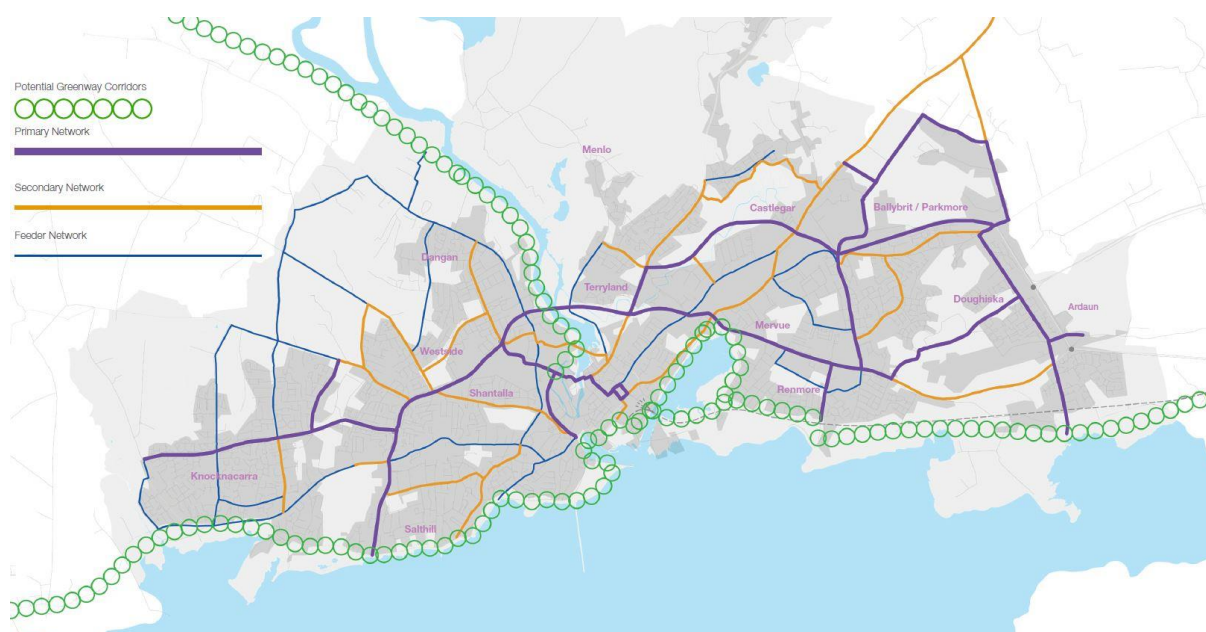
<sup>4</sup> The GTS includes that portion of the Galway to Oughterard Greenway between Galway City and Moycullen.

### 3.3 Cycling Network

The overall aspiration of the proposed cycle network is to provide a safe and comfortable environment for cyclists in the city and surrounding areas which will encourage a greater modal shift from the private car to cycling. The existing cycling facilities in the city and surrounding areas are limited and discontinuous. The proposal in the strategy is to provide high quality dedicated cycling facilities and improve measures giving priority to cyclists with the objective of encouraging a greater uptake in cycling both for commuting and as a leisure activity in the city and surrounding areas.

The overall cycle plan has been formulated on three levels of network (Primary, Secondary and Feeder) which support each other and reinforce connections across the study area as shown in Figure 2 below. The primary network comprises two greenways providing connectivity for cyclists from nearby towns and villages (Bearna, Oranmore and Maigh Cuilinn), a cross city route and some key north south links. Primary routes are generally either segregated, off-road cycle only paths, or dedicated cycle lanes along new or existing roads. As part of the primary route network and greenways a bridge crossing is proposed over the River Corrib downstream of Wolfe Tone Bridge from the Claddagh Quay to the Spanish Arch.

The secondary network provides connections from residential areas and areas of employment to the primary network, accessing key destinations. Secondary links are a combination of off-road cycle paths, cycle lanes along existing roads, shared bus and cycle lanes and traffic calmed roads, with feeder links connecting residential areas to these facilities, generally in the form of traffic management on these routes.



**Figure 2** *Proposed Cycle Routes and Greenways*

In terms of flood vulnerability the primary and secondary cycle routes within the city centre would be considered to be “less vulnerable development” or even “water compatible development” and the amenity / greenway routes to be “water compatible development”.

### 3.4 Public Transport

A bus network is proposed which will be characterised by the provision of reliable high frequency services, and will operate cross-city and thus improve east-west connectivity to include Bearna and Oranmore. Certain areas of the proposed bus network will be the focus of implementation of significant infrastructural priority measures (through the provision of new bus lanes, removal of pinch points and delays and maximising the efficiency and reliability of services on the network) so as to make this mode more attractive than the private car.

The regional/intercity/commuter bus and coach network will for the most part avail of the bus network infrastructure proposals within the city area, in addition to other proposals outside the city, including, for example, the Tuam Road Bus Corridor scheme which is currently under development.

The bus network can be considered to be an essential transport infrastructure for the city and therefore is classified as high vulnerable development in respect to flood risk. The proposed bus network may be augmented by localised services over time; however these are considered to represent less vulnerable development.



**Figure 3** *Proposed Public Transport Network*



### 3.5 Road Network

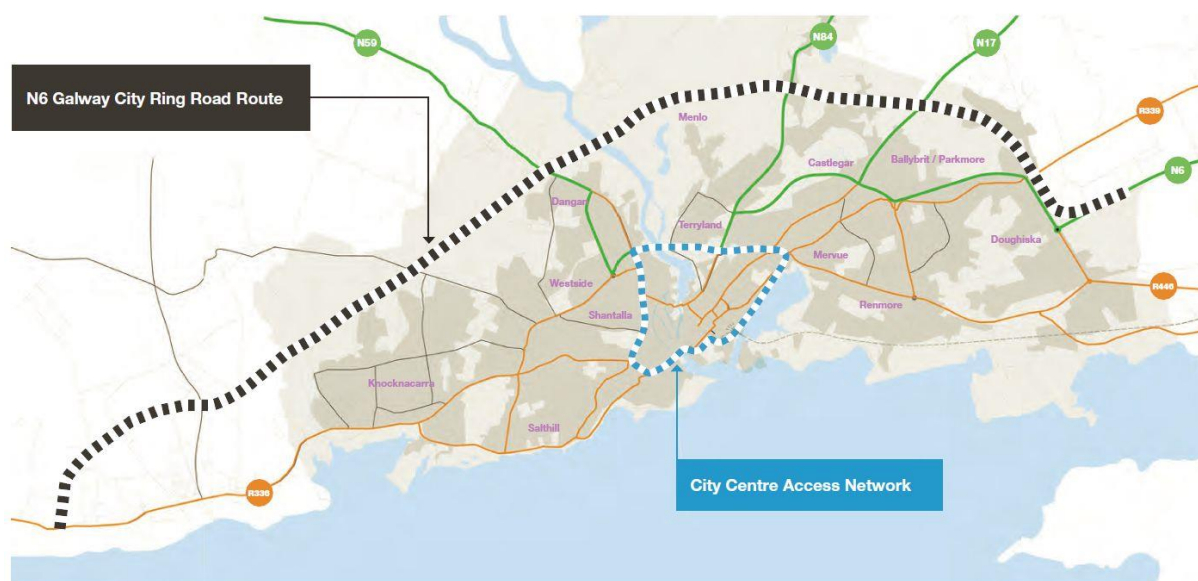
A defined “City Centre Access Network” is proposed to enable traffic to access and move around the core city centre area. This will involve revisions to road access, junctions and changes to flow direction.



**Figure 4 Galway City Centre Access Network**

The existing wider road network is crucial to the operation of the city and surrounding region. Even with the anticipated increased uptake in walking, cycling and public transport use, the regional and national road network within the study area is likely to suffer from increased congestion. In order to enhance Galway’s function as a regional city and permit continued growth an additional river crossing is required. The N6 Galway City Ring Road project has identified the most suitable corridor for an orbital road scheme for Galway. In addition to the orbital route a number of ancillary, localised road links are proposed to improve connectivity at the local level

It is considered that the existing national primary, secondary and regional roads (R446, R339, R336, N6, N17, N84 and N59) entering the city, the proposed N6 Galway City Ring Road and the proposed City Centre Access Network and Inner City Access Route are high vulnerability development given their strategic nature in terms of conducting traffic to, from and around the city and should ideally avoid flood risk areas (i.e. Zones A and B). Avoidance as a measure for the existing network may not be possible as such roads are existing and integral to the road network system.



**Figure 5 N6 Galway City Ring Road and national routes linking to the City Centre Access Network**

### 3.6 Park & Ride

It is proposed to provide park & ride sites on multiple approaches to the city which will be serviced by normal scheduled bus services. This will offer financial viability and offer a wider range of destinations with passengers being able to interchange between routes on the core bus network. This will provide alternatives to the private car for those accessing the city and thereby reduce traffic flows to and from the city.

The general areas for potential Park & Ride facilities have been identified in the vicinity of the M6, N17, and western approaches to the city.

## 4. STRATEGIC FLOOD RISK ASSESSMENT OF THE GTS

### 4.1 Overview of Sources of Flooding in Study Area

The SFRA has reviewed the potential for flood risk from fluvial coastal, pluvial and groundwater flooding as a result of the GTS and involved consulting:

- the OPW National Preliminary Flood Risk Assessment (pFRA) Mapping
- the OPW CFRAM (Catchment Flood Risk Assessment and Management) mapping for the Areas for Further Assessment (AFA) of Galway City and Oughterard Village and associated hydrological reports
- the Irish Coastal Protection Strategic Study - Western Coast and other relevant mapping including historical OSI mapping
- the OPW River Corrib Benefiting Lands mapping (developed as part of the River Corrib-Clare Arterial Drainage Scheme)
- known historical flooding areas and extents

The web portal floodmaps.ie provides a national archive of information on historical flood events including locations, reports, photographs, drawings and newspaper archives, which assists in the compilation of historical flood information. Other sources consulted as reference information are the SFRAs for the various LAPS including the City, Bearna, Oranmore SFRAs,

The sources of information on flood risk along the proposed infrastructure routes are summarised in Table 3 below

**Table 3 Flood Risk Source Evaluation**

Title	Description	Quality	Confidence
OPW – Arterial Drainage Land benefitting maps	Mapping of lands identified through walkover and consultation by OPW of lands	medium	Low to medium
Historical flood records including photos and reports	Various sources including various local authority records, reports, photos, archives and the floodmaps.ie repository	Variable	Low to high
OPW pFRA Mapping	The Preliminary Flood Risk Assessment (PFRA) national screening exercise to identify areas at flood risk and includes, pluvial, fluvial, groundwater and tidal.	Medium	Medium
Irish Coastal Protection Strategy Study	Prediction of tidal events under storm surge events for the western region which includes tidal levels and	High	High

Title	Description	Quality	Confidence
	coastal erosion of soft shoreline areas		
Walkover Survey	Specific visits to selected locations and key structures and flood defences	medium	Low
Western CFRAM (draft)	Draft Western CFRAM maps	High	High
SFRA for Development Plans	Stage 2 SFRA undertaken for Local Area and city and county Plans (Bearna, Oranmore, Claregalway, Moycullen, Oughterard, Spiddal, Galway City and Galway County)	Medium	Medium

The study area is located principally within Hydrometric Area 30 (River Corrib System) but also to the west within Hydrometric Area 31 and to the southeast in Hydrometric Area 29.

The pFRA mapping is generally used in Ireland in combination with other information as a coarse screening tool for identifying potential flood hazard and the requirement for further more detailed stage 2 and stage 3 flood risk assessments. This pFRA national mapping was produced from simplified river, pluvial and tidal surge hydraulic models using relatively coarse lidar data for flood routing purposes. Historical mapping and aerial flood photos were also relied upon in respect to groundwater and pluvial flooding. The pFRA mapping can only be treated as coarse, indicative mapping of potential flood hazards in an area and should be combined with other information sources.

The more detailed CFRAM study, carried out for identified AFA's (relevant to this strategy are Galway City, Oranmore and Oughterard), involve more detailed channel and floodplain survey, AFA lidar topographical survey, hydrological analysis and hydraulic flood modelling and provides more accurate and refined mapping for fluvial and coastal flood processes. It should be noted that the villages of Maigh Cuilinn and Bearna were not identified as AFA's and therefore do not have detailed CFRAM mapping available.

#### **4.1.1 Tidal and Coastal Flooding**

The main flood risk areas within the study area are the shoreline areas from Bearna to Oranmore and in particular low-lying lands below 4.2m O.D. Malin, namely Salthill Promenade area, Grattan Road, South Park, Claddagh Basin, the Spanish Arch, the

Long Walk, Flood Street, Lower Quay Street, Spanish Parade, Dock Street and Dock Road, Merchant's Road, Fr. Griffin Road, Fairhill, Dominick Street, Munster Avenue, and William Street West. These areas are at risk from flooding by tidal inundation during storm surge events. To date the highest storm event recorded reached a flood level of c. 3.6m O.D. in the Claddagh Basin. Areas that have previously flooded as a result of high tides are Grattan Road and adjoining dwellings primarily at Frenchville and properties fronting the road at South Park Place and Claddagh Avenue, Claddagh Quay, Docks Road, Merchant's Road Lower, Spanish Parade, Quay Lane and Flood Street.

Recurring flooding (approximately a 1 in 5 year) at Merchant's Road Lower, Spanish Parade, Quay Lane and Flood Street occurs due to urban storm drainage capacity which can be compounded by high tide levels and River Corrib flows.

Areas subject to flood risk from wave overtopping are Grattan Road, Martin Connolly (Mutton Island) Causeway, Southpark Shoreline Walkway to Nimmo's Pier and the Salthill and Seapoint promenade areas which saw extensive flooding by wave overtopping in December 2013/January 2014. Galway City Council in association with the OPW have carried out local minor works in terms of providing higher level of protection to Leisureland Complex and the Galway Business School. Demountable defences have been purchased to protect the Spanish Arch area from tidal flooding.

#### **4.1.2 Fluvial Flooding**

The study area falls within hydrometric areas 29, 30 and 31 (29 Galway Bay Southeast Catchment, 30 The Corrib Catchment, 31 The Galway Bay North

The principal rivers/streams within the study area are:

- Sruthán na **Líbeirtí**
- Trusky Stream
- Bearna River
- Knocknacarra Stream
- River Corrib and its canal system
- Terryland River
- The Oranmore River

The River Corrib represents the largest watercourse having a catchment area of some 3,135 km<sup>2</sup> to Salmon Weir in Galway City. The Office of Public Works (OPW) regulate water levels in the River Corrib and Lough Corrib through gated control at the Salmon Weir Barrage. The regulation level range for the lake is set at 28ft to 30ft Poolbeg (5.8 to 6.4m OD Malin) for navigation and flooding control. Gates are opened and closed by the OPW depending on existing and forecasted rainfall conditions. The canals and mill races through the city are fed by the River Corrib upstream of the Salmon Weir Barrage and outfall into the River Corrib Estuary. The Eglington Canal is prone to

siltation as the flow through this is restricted by lock gates, weirs and turbines. The other rivers/streams have catchments that are very minor in area in comparison and do not represent a significant source of flood risk with only localised flooding along their reaches.

The River Corrib represents a significant flood risk to the Headford Road area but this area is defended against flooding by the Dyke Road flood embankment which provides protection against the 100 year return period fluvial flood event but could be overtopped at the 1000 year return period fluvial flood. The canals downstream of the Salmon Weir Barrage in combination with flooding in the River Corrib present a flood risk to the Nuns Island area and Mill Street area at 1 in 1000 year return period fluvial event. No Flooding is predicted for the 1 in 100 year event.

Downstream of O'Brien's Bridge to the Claddagh Basin has combined flooding events from both sources of tidal and River Corrib fluvial flooding and presents a flood risk to this area.

#### **4.1.3 Pluvial Flooding Sources**

Pluvial Flooding results in the filling and ponding of runoff waters with within local depression topography areas which can result when rainfall intensity and duration exceed the infiltration capacity of the underlying soil causing temporary (over a few hours) building up of flood waters in such areas. In the national PFRA study a simplified model for pluvial flooding was developed which identified from aerial lidar data local depressions and their surrounding contributing catchment area. The potential for ponding and the extent of ponding was determined for these depressions using Met Eireann storm rainfall statistics and soil infiltration characteristics based on soil, subsoil and groundwater aquifer maps. These pluvial flood areas were mapped and presented in the PFRA Maps.

Potential pluvial Flood Risk Areas are shown scattered throughout the Galway City study area and are generally small and of limited consequence for the proposed transport network.

An area of pluvial flood risk that potentially could impact the transport network is the existing N17 Tuam Road section at Twomileditch. Regular flooding occurs during intense rainfall events with runoff from the steep hill slopes at Ballybrit flooding the N17 road and adjoining properties (Ryan Hanley Report (2004) N17 Flood Relief Project for Galway City Council). The N17 in times of severe flood acts almost as a streambed over its 1800m length conveying flood water along the road to discharge to groundwater to the northeast of the N17 road near Parkmore. This groundwater



discharge zone is potentially linked to the Castlegar area and the Terryland River Basin.

#### **4.1.4 Groundwater**

Groundwater flooding is associated with areas of high water table levels which can generally result in small areas of winter ponding of lands gradually filling and emptying between autumn and spring. These flood areas are generally referred to as seasonal lakes or turloughs. They are generally slow to fill and often slower to recede and within the study area are associated with the karst limestone bedrock to the east of the River Corrib. Turlough Features are also present in the Moycullen, Oranmore and Claregalway areas. The N59 generally represents the boundary between granite and limestone bedrock. The limestone areas to the east of the city give rise to small turlough features, karst springs and swallow-hole systems and areas vulnerable to flooding are the Doughiska, Ardaun and Glennascaul and the Carnmore areas. A flood relief culvert has been provided to relieve flooding in Doughiska area taking the pluvial and groundwater flows and discharging to the sea via a 1500mm diameter storm pipe. The Terryland (or Sandy) River flows east to northeast from the River Corrib for approximately 4km before discharging to ground via two swallow holes at Glenanail, Castlegar. The inflow from the River Corrib is via a manmade channel referred to as the Galway Bore which is also the abstraction / intake channel to the Terryland water treatment plant. The excess flow overspills with a fall of 3m down into the Terryland River Basin. Historical maps (1819) showed the entire Terryland River valley as inundated and part of the River Corrib system. The capacity of the swallow-holes is unknown and a previous 1998 KT Cullen Study for Galway City Council recommended that development levels are set above 7m OD which is equivalent to the River Corrib level in severe flood (> 100year Return Period in River Corrib upstream of Salmon Weir Barrage). The CFRAM model study makes certain assumptions with predicted levels significantly lower at 3.4 and 4.94m OD for the 100 and 1000 year events for the Terryland River valley. A level of uncertainty over the current and future capacity of the swallow holes remains.

#### **4.1.5 Urban Stormwater Drainage**

In Galway the urban storm water drainage system varies between new separated storm sewers and older separated and combined storm sewers. The storm water sewer system in places has been upgraded so as to reduce flash storm water flooding. The design standard varies but generally for the more recent storm water sewers a 30year surcharge capacity is provided. Storm water gullies are prone to blockage which can give rise to localised flooding issues as can storm water outfalls. The use of attenuation tanks for housing developments, hard paved areas and roadways as part of SUDS (Sustainable Urban Drainage System) with storage and restricted outfall

discharge can give rise to flood hazards where the outfall is blocked through lack of maintenance or its storage capacity has been exceeded.

Generally Urban Drainage investigation and analysis is more typical of stage three flood risk assessment requiring the link between the sewer network model and the 2d model of the urban topography to determine the flow pathways and the flood zone mapping.

#### 4.1.6 Climate Change

The biggest threat to coastal flood risk areas is from sea level rise. Global mean sea levels are predicted to increase from a combination of thermal expansion of the water column and melt from the glaciers and reduction of liquid water storage on land. The Intergovernmental Panel on Climate Change Third Assessment Report (*IPPC TAR*) that preceded the published *IPCC Fourth Assessment Report* (2007) has been used as the basis of future sea level projections for Ireland. A best estimate increase of 480 mm to year 2100 has been suggested by Sweeney et al (2003) and used in the *Greater Dublin Strategic Drainage Study* (GDSDS 2005). This value was not directly challenged in the 2007 *IPCC* report, with a range of 0.2 - 0.51 m given for the prudent Medium-High A2 emission scenario.

The UK DEFRA (2006) publication suggests for the UK and globally that significantly higher rates of sea level rise, particularly towards the end of the century, than the 500mm allowance that is currently considered.

**Table 4 The UK Flood and Coastal Defence Appraisal Guidance (DEFRA, 2006)**  
**Regional Net Sea Level Rise Allowances**

Region	Assumed vertical land movement (mm/yr)	Net Sea-Level Rise (mm/yr)				Previous Allowances
		1990-2025	2025-2055	2055-2085	2085-2115	
East of England	-0.8	4.0	8.5	12.0	15.0	6mm/yr constant
South West and Wales	-0.5	3.5	8.0	11.5	14.5	5mm/yr constant
NW & NE England, Scotland	+0.8	2.5	7.0	10.0	13.0	4 mm/yr constant

The latest IPCC fifth Assessment Report (2014) has investigated the current and future trends in global mean sea level rise (GMSLR) and have concluded with a high level of confidence under various emission scenarios considered (four modelled RCPS (Representative Concentration Pathways) that thermal expansion of the sea due to warming will increase Global mean sea level by between 0.15 to 0.3m by 2100. This

report predicts at medium confidence the contribution of glacier mass loss to GMSLR for the four RCP scenarios. The global glacier volume is projected to decrease by 15 to 55% for RCP2.6, and by 35 to 85% for RCP8.5 and in between these rates for the other two RCP scenarios. RCP2.6 is representative for scenarios leading to very low greenhouse gas concentration level, it is a so called “peak” scenario with radiative forcing reaching a peak level of  $3.1 \text{ W/m}^2$  mid-century and returning back to  $2.6 \text{ W/m}^2$  by 2100. RCP8.5 is characterised by increasing greenhouse gas emissions overtime leading to high greenhouse gas concentrations by 2100.

Projections of GMSLR by 2100 under the high RCP8.5 scenario are 0.53 to 0.98m with rises of 8 – 16mm/annum during 2081 to 2100 and under the low RCP2.6 scenario are a rise is 0.28 to 0.61mm.

Observations of GMSLR show that from 1901 to 1990 1.5mm per annum mean rise and from 1993 to 2010 the mean rise was 3.2mm per annum.

The IPCC concluded that it is very likely that sea level will rise in more than about 95% of the ocean area. About 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change. GMSLR during 1901–2010 can be accounted for by ocean thermal expansion, ice loss by glaciers and ice sheets, and change in liquid water storage on land. It is very likely that the 21st-century mean rate of GMSLR under all RCPs will exceed that of 1971–2010, due to the same processes. It is virtually certain that global mean sea level rise will continue for many centuries beyond 2100, with the amount of rise dependent on future emissions.

The Irish Coastal Protection Strategy Study prepared by RPS on behalf of the OPW (RPS, 2010) uses a Mid-Range Future Scenario (MRFS) reflecting changes that are within the typical range projected for mean sea level rise of 500mm. The glacial isostatic adjustment for land movement along the west coast is projected to be very minor. An allowance of 500mm mean sea level rise to the year 2100, which accounts for a 500mm increase in mean sea level and no increase for isostatic land movement adjustment was included in that study to simulate a potential mid-range future climate change scenario.

The Flood Risk Planning Guidelines recommends a precautionary approach to climate change effects in respect to flooding due to the high level of uncertainty in predicting its effects. It recommends the following in this respect:

- Caution in zoning lands in these potential transitional areas that would be impacted if climate change predictions occur

- Ensuring that the level of structures designed to protect against flooding are sufficient over the lifetime of the design to cope with the effects of climate change
- Ensuring that structures to protect against flooding and the development are capable of adaption to the effects of climate change when there is more certainty as to the effects

Notwithstanding the above precautionary principle the flood risk zones defined in the Flood Risk Planning Guidelines are based on the present day assessment of the 100 year (1%) and 1000 year (0.1%) return period for fluvial flooding and the 200 year and 1000 year for tidal flooding. The OPW provide specific guidance as to the allowances in their publication entitled “Assessment of Potential Future Scenarios, Flood Risk Management Draft guidance, 2009 and these allowances are summarised in Table 5.

**Table 5 Climate Change Allowances for Future Scenarios 100 year**

Criteria	Mid-Range Future Scenario MRFS	High-End Future Scenario HEFS
Mean Sea Level Rise	+500mm	+1000mm
Land Movement	-0.5mm/year	-0.5mm/year
Extreme Rainfall Depths	+20%	+30%
Flood Flows	+20%	+30%

## 4.2 Stage 1 Flood Risk identification

The proposed transport measures and transport networks were provided digitally and overlaid in GIS with OSI background mapping and relevant flood risk mapping for flood hazard identification and flood risk quantification purposes.

The indicative routes of the proposed networks for the various Galway Transport Strategy measures (walking, cycling, bus and road networks) have been superimposed onto the OPW pFRA and draft CFRAM Flood Risk mapping which is included in Appendix A to this report. This mapping demonstrates at numerous locations the close proximity and potential encroachment of the various transport measures to various flood risk areas.

### 4.2.1 GTS Walkway Network

The key walkway locations of University Road, Cathedral Quarter, Courthouse, St. Francis Street/Eglinton Street, Eyre Square, Ceannt Quarter and College Road some of which form part of the Cross-City Link are generally safe from flooding as they are within Flood Zone C. A crossing of the River Corrib is proposed which by its nature

will cross Flood Zones A and B associated with the river channel. The greenway areas which will facilitate walking are shown in many locations to be in the high flood risk zone from generally coastal and fluvial flood risk.

#### **4.2.2 GTS Cycle Network**

The cycle network is shown to be at risk from coastal, fluvial and pluvial flood sources with the path of primary cycle network along the Galway City coastline situated within the extreme and indicative coastal flooding extents at various locations, particularly along Salthill Promenade, the Claddagh area, the Galway Docks area and Lough Atalia. The proposed cycle network also has a potential fluvial flood risk from the Terryland River basin and the River Corrib floodplain. A number of smaller streams to the west towards Bearna are also crossed by the proposed cycle network including the Knocknacarra Stream, the Bearna Stream, the Trusky Stream and the Sruthán na Líbeirtí Stream. Local pluvial flood risk sources (ponding within topographical depressions) have also been identified at a number of locations within the proposed cycle network. The proposed Galway to Oughterard Greenway crosses a number of tributaries of the River Corrib along its indicative route. It also traverses through and adjacent to the flood plain of the River Corrib and Lough Corrib and the Owenriff River Floodplain at Oughterard along its proposed indicative route.. The current draft CFRAM mapping also confirms these sources of potential coastal and fluvial flood risk to the proposed cycle network. The OPW Benefitting Lands mapping (used as an indicator of fluvial Flood risk also identifies fluvial flood risk) from the River Corrib catchment.

#### **4.2.2 GTS Road Network**

The proposed N6 GCRR and its various road linkages and junction upgrades are shown, from the various flood risk mapping sources, to have the potential to intercept fluvial, groundwater and pluvial flood risk sources. The proposed N6 GCRR corridor crosses the River Corrib at the townlands of Menlough and Dangan where it has the potential to encroach the river channel and its floodplain. The proposed road development also crosses a number of smaller streams to the west towards Bearna including the Knocknacarra Stream, the Tonabrocky Stream, the Bearna Stream, the Trusky Stream and the Sruthán na Líbeirtí Stream. A potential source of groundwater flooding is identified adjacent to its corridor at Doughiska, Coolagh and Castlegar areas and potential pluvial sources at a number of locations along its corridor. Coastal flood risk has generally not being identified for the other proposed road links and junction upgrades with the exception of a proposed upgrade at the junction of College Road and Lough Atalia.

#### **4.2.3 GTS Bus Network**

The proposed bus network including new bus routes and bus corridors is shown to potentially have flood risk from various coastal, groundwater, pluvial and fluvial sources based on the pFRA mapping and also historical information.

#### **4.2.4 Summary of Stage 1 Flood Risk Identification**

It is important to note that the information relied on for the Stage 1 screening assessment (particularly the pFRA mapping, the OPW land benefitting mapping and the Irish Coastal Protection Strategic Study mapping) is only indicative and may both exaggerate or underestimate and possibly miss out altogether flood hazards. Nevertheless there is sufficient information available for the screening assessment to conclude that the various measures of the proposed Galway Transport Strategy have potential flood risk from the following sources coastal, fluvial, pluvial, groundwater and urban drainage. It is therefore concluded that a Stage 2 Flood Risk Assessment for this Transport strategy is required in order to assess and manage flood risk in accordance with the Flood Risk Management Planning Guidelines.

### **4.3 Stage 2 Initial Flood Risk Assessment**

#### **4.3.1 Introduction**

This Stage 2 assessment investigates in more detail the flood risk implications and management options associated with the various modes of transport in the Galway Transport Strategy. The draft CFRAM maps were used to inform the Stage 2 assessment in respect to fluvial and coastal sources. Although the CFRAM mapping is currently in draft format this mapping has undergone public consultation and full review and is considered to be close to finalised mapping. It is expected that this mapping and the CFRAM assessments will be regularly updated and reviewed into the future.

By the nature of transport infrastructure crossing of watercourses (rivers estuaries and floodplains) are often unavoidable as the purpose is to link lands that are likely to be separated by a number of watercourses. A sequential approach may be adopted in respect to a route selection process for a project which takes into account many environmental factors which include flood risk and hydrology to select the most suitable route. In the transport strategy there are three new potential crossings of the River Corrib proposed, one at the Dangan-Menlough Area for the N6 Galway City Ring Road, a second bridge crossing downstream of the Salmon Weir Bridge for pedestrian purposes and the third crossing in the estuarine section downstream of the Wolfe Tone Bridge for the cycle network. The strategy also considers construction of a bridge along the line of the Old Clifden Railway at NUI Galway/Waterside using the existing piers already in place; however as this does not involve further new additional constrictions to the river it is not considered to increase flood risk. The N6 GCRR will

also cross other minor water courses which are small and of limited floodplain area and will only require culverting of the channel to facilitate the road. The following tables documents the SFRA for each of the transport modes within the GTS.

#### 4.3.2 Proposed Pedestrian Network – Cross City Link

**Table 6 SFRA for the Proposed Pedestrian Network – Cross City Link**

Site Description	It is proposed to provide a new pedestrian bridge crossing of the River Corrib downstream of the Salmon Weir Bridge and thereby remove pedestrians from the Salmon Weir Bridge. Other supporting measures for walking include the upgrade of road junction layouts and where appropriate, providing dedicated pedestrian crossings, providing permeable pedestrian environments in residential areas, reviewing speed limits in the core city centre and removing unnecessary street clutter to facilitate ease of movement along streets.
Vulnerability Category	Pedestrian routes within the city centre would be considered to be less vulnerable development. The greenway routes would be considered amenity type development and therefore water compatible development in accordance with FRMPG.
Flooding mechanism	Potential fluvial flooding from the River Corrib and its canals downstream of the Salmon Weir Barrage.
Benefitting from Flood defences or Flood relief scheme	The levels and to a lesser extent the flows in the River Corrib are controlled by the OPW who operate the Salmon Weir Barrage. The River Corrib channel downstream of the Salmon Weir Barrage to the Claddagh Basin was deepened as part of the Corrib Arterial drainage Scheme in the early 1960's.
Historical Flooding	No Flooding from the River Corrib was noted previously in the vicinity of Salmon Weir Bridge.
Flood Risk	Generally the inner city area is within Flood Zone C except where a crossing of the River Corrib and the adjacent canal is required. The proposed crossing point will be in the reach downstream of the Salmon Weir Bridge and this section of river was modelled as part of the CFRAM Study. The Study shows that banks on either side are outside of the flood Risk Area. There is no coastal (wave or tide) flood risk to the Cross-City Link locations.

Climate Change	The predicted increases in fluvial flood flows of 20 to 30% are unlikely to have a significant effect on flood risk in this reach section with ample capacity available within the river channel.
Residual Risk	A potential residual risk is present to this section of the River Corrib if a significant section of the Salmon Weir structure was to collapse but such a risk is very low given the operation and configuration of the gated weir structure and the slow nature of flooding in the River Corrib.
Development Considerations and Flood Risk Management	<p>A detailed assessment of the pedestrian bridge crossing and the impact of any bridge piers and abutments on flood levels and scour velocities in the river channel and on the floodplain is required.</p> <p>The bridge design should include appropriate climate change allowances for flood flows and sea level rise and provide suitable clearance above the design flood level to reduce shading and allow for debris passage and freeboard for uncertainty and climate change.</p> <p>Section 50 approval from the OPW under the 1945 arterial drainage act shall be obtained for this bridge crossing.</p>



### 4.3.3 Proposed Cycle Network

**Table 7 SFRA for the Proposed Cycle Network**

Site Description	The overall cycle network has been formulated on three levels of network (Primary, Secondary and Feeder) which support each other and reinforce connections across the study area. The primary network comprises three greenways providing connectivity for cyclists from nearby towns and villages (Bearna, Oranmore and Maigh Cuilinn), a cross city route and some key north south links. Primary routes are either segregated, off-road cycle only paths, or dedicated cycle lanes along new or existing roads. As part of the primary cycle network a bridge crossing is proposed over the River Corrib downstream of Wolfe Tone Bridge from the Claddagh Quay to Long Walk. The various cycle routes (secondary and feeder) criss cross the city utilising the existing road infrastructure.
Vulnerability Category	The vulnerability category of the cycleway routes within the city centre would be considered to be less vulnerable development to almost water compatible development and suitable for development within Flood Zone A. The primary cycle network including greenways would be considered amenity type development and therefore water compatible development suitable for development within Flood Zone A.
Flooding mechanism	Coastal (tide and wave), Combined (fluvial and tide), fluvial flooding from the River Corrib and other watercourse intercepted and pluvial and local urban storm water flooding.
Benefitting from Flood defences or Flood relief scheme	<p>The levels in the River Corrib are controlled by the OPW who operate the Salmon Weir Barrage. The River Corrib channel was also deepened as part of the Corrib Arterial Drainage Scheme in the early 1960's with the Salmon Weir replacement barrage constructed by the OPW in 1959. The Dyke Road embankment protects the Bodkin Junction, the approach roads to this junction and the Headford Road.</p> <p>There are no coastal flood defences protecting the flood prone areas along these routes except for local protection measures at Leisureland and the Galway Business School in Salthill.</p>
Historical Flooding	No Flooding from the River Corrib or the Terryland River since the Arterial Drainage Scheme has been

	<p>implemented. Recurring tidal flooding along the Galway Coastline from Bearna to Oranmore and beyond. This includes the Salthill and Seapoint Promenades, the Claddagh/Southpark area, the Spanish Arch, Docks area, the Renmore shoreline, Roscam shoreline and the Old Dublin Road coastal section on the approaches to Oranmore.</p>
Flood Risk	<p>Within the city where the proposed cycle routes utilise the existing road network the flood risk is from the River Corrib at the Headford Road which is protected by the Dyke Road embankment. The network is also at risk from coastal flooding around the Claddagh and Galway Docks area. All of these locations are shown to be in Flood Zone A.</p> <p>The proposed new development on the cycle network is associated with the proposed greenways. In particular the Galway City to Oranmore section of the Galway to Dublin Cycleway and the Bearna Greenway is vulnerable to coastal flooding from tide and wave overtopping along certain sections. The extent of the fluvial and coastal flooding is presented in the CFRAM draft maps for Oranmore AFA and Galway City AFA. The proposed Galway to Oughterard Greenway generally follows the old Clifden rail line and in places is located within the floodplain of the River Corrib and Lough Corrib and traverses a number of its tributaries along its indicative route.</p> <p>A new bridge crossing is proposed downstream of Wolfe Tone Bridge as part of the cycle network proposals. The banks on either side of this crossing are within the tidal Flood Zone A. The CFRAM study provides reliable Flood level data for this proposed bridge section location.</p> <p>Pluvial flooding at frequencies greater than 100 year have been identified along the Twomileditch area of the N17 Tuam Road where a secondary cycle route to Claregalway is proposed (Ryan Hanley/Hydro Environmental Study). The Twomileditch section of road is in Flood Zone A.</p> <p>Of concern to the proposed greenways along the coast is potential for coastal erosion of the soft shoreline</p>

	<p>areas. These area are identified in the Irish Coastal Protection Strategic Study for the West Coast of Ireland.</p>
Climate Change	<p>Climate change in terms of predicted sea level rise will increase the exposure of the coastal cycle ways to wave overtopping and tidal flooding and to coastal erosion and increase the length of greenway within the Flood Zones A and B if climate change allowances are included.</p> <p>A 20 to 30% increase in fluvial flood flows will increase Lough Corrib and River Corrib levels which may impact on the Galway to Oughterard Greenway.</p>
Residual Risk	<p>A residual risk exists for the Terryland area in the event of overtopping or breach in the Dyke Road embankment and the mal-functioning of the Salmon Weir Barrage hydraulic gates.</p> <p>A breach of the Salmon Weir Barrage could create a dambreak type residual flood risk to its downstream reach and estuary areas but such a risk is very low given the operation and configuration of the gated weir structure and the slow nature of flooding in the River Corrib.</p>
Development Considerations and Flood Risk Management	<p>It is considered that generally the cycle network is water compatible development type and therefore may be developed within Flood Zone A provided the development is sustainable and does not impact on flood risk to adjacent properties and lands. However the proposed greenways should avoid where feasible Flood Zone A and should be of a formation level that minimises flood risk provided it does not result in a flood risk impact to adjacent lands. Where the development is located within Flood Zone A it should be of a construction type that is resilient to flooding.</p> <p>In terms of coastal flooding routes such as the Galway City to Oranmore section of the Galway to Dublin Cycleway and the Bearna Greenway avoidance of coastal flood risk should be prioritised where possible and in particular where potential for shoreline erosion has been identified in the OPW Irish Coastal Protection Strategic Study – West Coast of Ireland.</p> <p>A stage 3 site specific detailed flood risk assessment should be carried out at the detailed design stage to ensure sustainable development in flood risk areas.</p>

	<p>Given the sudden nature of coastal inundation flood events, flood warnings and flood management measures should to be put in place to safe guard cyclists in wave exposed sections of the cycle route.</p> <p>A stage 3 detailed flood risk assessment of the proposed River Corrib crossing for the cycle network and the impact of any bridge piers and abutments on flood levels and scour velocities in the river channel and on the floodplain should be carried out to ensure no residual impacts arise from such a development particularly given the sensitivity of the Claddagh Basin/ Spanish Arch area to flooding.</p> <p>The bridge design should include appropriate climate change allowance for flood flows and sea level rise and provide suitable clearance above the design flood level to reduce shading and allow some navigation. Section 50 approval from the OPW under the 1945 Arterial Drainage Act should be obtained for this potential bridge crossing.</p>
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#### 4.3.4 Proposed Public Transport Network

**Table 8 SFRA for the Proposed Public Transport Network**

Site Description	<p>A bus network is proposed which will be characterised by the provision of reliable high frequency services and will operate cross-city and thus improve east-west connectivity to include Bearna and Oranmore. Certain sections of this proposed bus network will be the primary focus for implementation of significant infrastructural priority measures. This will be through the provision of new bus lanes, removal of pinch points and delays and maximising the efficiency and reliability of services on the core network so as to make this mode more attractive than the private car.</p> <p>The regional/intercity/commuter bus and coach network will for the most part avail of the bus network infrastructure proposals within the city area in addition to other proposals outside the city, including the Tuam Road Bus Corridor scheme which is currently under development.</p> <p>This infrastructure utilises and reconfigures the existing road network.</p> <p>The Cross City Link/City Centre Access Network comprises a Bus Priority/Bus Only from the train and bus/coach stations past Eyre Square, onwards to Woodquay and over the River Corrib past the Cathedral to join the Newcastle Road at the University Road / Newcastle Road Junction.</p>
Vulnerability Category	<p>The bus network can be considered to be essential transport infrastructure for the city and therefore is classified as highly vulnerable development in respect to flood risk.</p>
Flooding mechanism	<p>Fluvial flooding from the River Corrib and potentially the Terryland River if its swallow holes become blocked. Fluvial flooding from Knocknacarra Stream on Western Distributor Road.</p> <p>There may also be potential for urban drainage issues at times of extreme rainfall events.</p>

	Coastal Flooding along its coastline routes which includes the route that runs along the Salthill Promenade Road and at Lough Atalia.
Benefitting from Flood defences or Flood relief scheme	<p>The levels in the River Corrib are controlled by the OPW who operate the Salmon Weir Barrage. The River Corrib channel was also deepened as part of the Corrib Arterial Drainage Scheme in the early 1960's with the Salmon Weir replacement barrage constructed by the OPW in 1959. The Dyke Road embankment protects the Bodkin Junction, the approach roads to this junction and the Headford Road.</p> <p>There are no coastal flood defences protecting the flood prone areas along these routes except for recent local coastal protection at Leisureland and at the Galway Business School in Salthill.</p>
Historical Flooding	<p>No flooding from the River Corrib or the Terryland River since and possibly before the Arterial Drainage Scheme was completed in the 1960s. Historically the Dyke Road embankment has been present since the 1800's.</p> <p>Recurring coastal flooding of the Salthill Promenade, the Claddagh/Southpark, the Spanish Arch and Docks areas.</p>
Flood Risk	<p>The red bus route via Salthill that runs along the Salthill Promenade past the Leisureland Complex is prone to wave overtopping during high tides placing this section of network in Flood Zones A and B.</p> <p>The blue bus route from the city centre to Castlegar via the Headford Road is shown to be within Flood Zone A based on the CFRAM detailed study. This area is classified as "protected lands" by the OPW and is protected up to the 100 year fluvial flood event by the Dyke Road embankment. However, this area and the Headford Road is considered to be vulnerable to the 1000 year flood event and has a residual flood risk in the event of breach or overtopping of the embankment defence.</p> <p>The CFRAM mapping shows that the Lough Atalia Road from the College Road Junction to the Old Dublin Road,</p>

	Wellpark Road and Moneengeisha Road Junction to be within the 1000 year tidal flood extent Flood Zone B Coastal where brown, yellow, red and green bus routes traverse.
Climate Change	The predicted increases in fluvial flood flows of 20 to 30% potential could overtop the Dyke Road embankment as its design standard is the current 100 year event. Sea level rise represents a significant concern for the Lough Atalia Road to Old Dublin Road Junction and to increase wave overtopping along the Salthill Promenade.
Residual Risk	<p>A residual risk exists for the Terryland area in the event of overtopping or breach in the Dyke Road embankment and the mal-functioning of the Salmon Weir Barrage hydraulic gates (hydraulic failure of gates to open).</p> <p>All bus routes are over the Salmon Weir Bridge have a potential residual Flood Risk should a large breach of the weir occur but such a risk is very low given the operation and configuration of the gated weir structure and the slow nature of flooding in the River Corrib.</p>
Development Considerations and Flood Risk Management	<p>The proposed strategy is to utilise the existing road network with traffic flow type upgrades and therefore avoidance of the flood risk areas is not achieved.</p> <p>There is little in the way of mitigation that can be provided in terms of road design. To fully protect the areas utilised by the public transport network and the associated affected roads a large flood relief scheme is required given the extent of the flood area and length of exposure to the sea and estuary. Some demountable measures could be considered to protect the areas.</p> <p>For the areas affected by flood risk, flood warning and flood and traffic response measures need to be included so that road closures and detours are timely introduced so as to protect welfare of road users, minimise damage and minimise traffic congestion. Such warnings are currently available during times of predicted storm surge events by Galway City and County Councils.</p> <p>Should sea level rise achieve the levels predicted, flooding could occur more frequently and to a greater</p>

	<p>depth which could disrupt the public transport route operation.</p> <p>Future new structural development works to the public transport network within the identified flood risk zones whether they are minor or major development works should have a stage 3 site specific Flood Risk Assessment carried out so as to meet the requirements of the Flood Risk Management Planning Guidelines. This assessment should ensure that such works will not impact on flood risk to the area and that an integrated flood management plan including an evacuation plan are designed and put in place.</p>
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#### 4.3.5 The Proposed Road Network – N6 GCRR

**Table 9 SFRA for the Proposed Road Network – N6 GCRR**

Site Description	<p>The corridor for the N6 GCRR connects the R336 on the coast road across the River Corrib to connect to the existing N6 on the east.</p> <p>The scheme will comprise a Type 1 Single Carriageway in the west connecting to a Type 1 Dual Carriageway at the Ballymoneen Road.</p> <p>The corridor for the N6 GCRR and its associated link roads generally avoid the fluvial floodplain area. The proposed crossing of the River Corrib at Dangan is primarily within channel, with only very slight overbank flooding on both bank edges under 100 year and 1000 year flood flow scenarios.</p>
Vulnerability Category	New road and essential infrastructure category and is considered to be highly vulnerable development in accordance with the FRMPG
Flooding mechanism	River Corrib Fluvial Flooding from the River Corrib, the Bearna, the Truskey, the Knocknacarra, and the Sruthan na <b>Líbeirtí</b> Streams.
Benefitting from flood defences or flood relief scheme	The levels in the River Corrib are controlled by the OPW who operate the Salmon Weir Barrage. The River Corrib channel was also deepened as part of the Corrib Arterial drainage scheme in the early 1960's with the Salmon Weir replacement barrage constructed by the OPW in 1959.
Residual Risk	<p>The soffit level of the proposed River Corrib Bridge will be required to provide a sufficiently large freeboard to enable navigation and therefore no residual risk will apply to the bridge in the event that the Salmon Weir Barrage gates fail to open.</p> <p>Potential blockages to culverts and bridges on the other streams and the lack of maintenance could present a localised residual flood risk.</p>
Historical Flooding	There is a gauge at Dangan which has recorded the recent floods of December 2015/January 2016 and the previous floods of November 2009 and December 2006.

	<p>The levels recorded in December 2015 and early January 2016 have been the highest recorded since the construction of the OPW Salmon Weir Barrage (1959) and associated arterial drainage works to the Corrib Channel (early 1960s).</p>
Flood Risk	<p>The section of the River Corrib at the crossing point of the N6 GCRR has been modelled in the CFRAM detailed study and predictions for the 100 year and 1000 year events are available and considered to be of high confidence.</p> <p>Other stream crossings are ungauged and are not included in the CFRAM Study and therefore predictions are of low to medium confidence. The topography and small catchment areas ensure that the associated flood zones to these streams are very localised with relatively narrow floodplain widths along these streams.</p>
Climate Change	<p>The predicted increases in fluvial flood flows of 20 to 30% should be considered and should easily be catered for in the design</p>
Development Considerations	<p>A drainage neutral approach to disposal of surface runoff is required utilising the principals of Sustainable Urban Drainage systems (SUDs) in terms of storm water attenuation and water quality treatment.</p> <p>A stage 3 detailed flood risk assessment of the River Corrib Bridge crossing and the impact of any bridge piers and abutments on flood flows in the river channel and on the floodplain is required.</p> <p>A stage 3 detailed flood risk assessment of all watercourse crossings to ensure no significant impacts on flooding from the road construction and that the proposed road is not at risk of flooding and meets the standards of the FRMPG is required. This shall also include assessment of the Knocknacarra Stream, the Bearna Stream, the Trusky Stream and the Sruthan na <b>Líbeirtí</b> and any other smaller drainage channels.</p> <p>All designs should consider suitable climate change allowance of 20% to 30% increase in flood flows and provide adequate clearance between design flood level and soffit level.</p>

	Section 50 approval from the OPW under the 1945 arterial drainage act shall be obtained for all watercourse crossing structures (bridges and culverts alike).
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#### 4.3.6 Proposed Road Network – The City Centre Access Network

**Table 10 SFRA for the Proposed Road Network – The City Centre Access Network**

Site Description	The Galway City Centre Access Network utilises existing road infrastructure to facilitate an orbital road around the core of the city centre and to pick up all of the national and regional roads. Vehicular traffic will travel both directions on the Lough Atalia Road, will use the existing one way system around the Docks and Merchants Road. Traffic will travel in both directions across Wolfe Tone Bridge, along Father Griffin Road, the Crescent, St. Mary's Road, Newcastle Road to N6 and over the Quincentenary Bridge to the Bodkin Junction and along the R338 to rejoin the Lough Atalia Road. Upgrade to existing junctions and traffic flow will be required to facilitate this City Centre Access Network.
Vulnerability Category	The existing road network, given its proposed role as the primary road for access to, from and around the inner core city centre, would be considered to be essential infrastructure and therefore "highly vulnerable development". Flooding of this route could seriously disrupt its functionality with the potential for major delays and traffic disruption.
Flooding mechanism	Flooding sources for the Galway City Centre Access networks is from tidal, combined and fluvial flooding from the River Corrib and potentially the Terryland River if its swallow holes become blocked. Another source of flooding is from the urban drainage networks in the vicinity of Flood Street and the Docks area that can occur independently and combined with tides.
Benefitting from Flood defences or Flood relief scheme	The levels in the River Corrib are controlled by the OPW who operate the Salmon Weir Barrage. The River Corrib channel was also deepened as part of the Corrib Arterial drainage scheme in the early 1960's with the Salmon Weir replacement barrage constructed by the OPW in 1959. The Dyke Road embankment protects the Bodkin Junction, the approach roads to this junction and the Headford Road.

	There are no coastal flood defences protecting the flood prone areas along this route.
Historical Flooding	There has been no flooding from the River Corrib or the Terryland River since the Arterial Drainage Scheme has been implemented. Recurring tidal flooding has occurred in the vicinity of the Docks and the Flood Street and the Wolfe Tone bridge approach road in front of Jury's Hotel. Recurring urban drainage flooding has occurred in the Flood Street area adjacent to Docks Road.
Flood Risk	<p>The area in which the Galway City Centre Access Network is located has been modelled in the CFRAM detailed study and predictions for fluvial events from the River Corrib and its canals are available for the 100 year and 1000 year events having a high degree of confidence. The CFRAM study shows that the vulnerable section is the Bodkin Junction and a section of the approach roads on the N6 and the Sean Mulvoy Road R338. This area is shown to be within Flood Zone A but the lands are protected by the Dyke Road embankment and vulnerable to flooding from the 1000 year flood event.</p> <p>The CFRAM also assesses Tidal and Wave Flooding of Lough Atalia and the Claddagh Basin with predictions for the 200 year and 1000 year events available, having a high degree of confidence. The CFRAM mapping shows that the Lough Atalia Road and junction with the Old Dublin Road, Wellpark Road and Moneengeisha road are within the 1000 year tidal flood extent and are therefore in Flood Risk Zone B. The Dock Road area and Merchants Road is shown to be within the 200 year flood zone for tidal flooding with a small section within the 10 year flood extent, therefore this area is within Flood Zone A for tidal flooding. At the 200 year tidal flood event a considerable section of this road is shown to flood with flood water depths varying from &lt; 0.25m to 1m.</p> <p>There are also urban drainage network issues in the vicinity of Flood Street and potential for flooding of the road from urban drainage network at the lowered section of the Lough Atalia Road under the Railway Bridge.</p>
Climate Change	The predicted increases in fluvial flood flows of 20 to 30% potential could overtop the Dyke Road

	<p>embankment as its design standard is the current 100 year event. Sea level rise represents a significant concern for the Lough Atalia Road, Docks and Merchants Road areas and the Wolfe Tone and lower section of Fr. Griffin Road. A sea level rise of 500mm (medium range prediction) could result in more frequent tidal flooding of these areas and an extreme tidal flood event in the Docks and Claddagh Area resulting in major flooding of this area of the city.</p>
Residual Risk	<p>A residual risk exists for the Terryland area in the event of overtopping or breach in the Dyke Road embankment and the mal-functioning of the Salmon Weir Barrage hydraulic gates.</p> <p>A breach of the Salmon Weir Barrage could create a dambreak type residual flood risk to its downstream reach and estuary areas but such a risk is very low given the operation and configuration of the gated weir structure and the slow nature of flooding in the River Corrib.</p>
Development Considerations and Flood Risk Management	<p>The proposed strategy is to utilise the existing road network with traffic flow type upgrades and therefore avoidance of the flood risk areas will not be achieved.</p> <p>There is little in the way of mitigation that can be provided in term of road design. To fully protect the areas utilised by the City Centre Access Network and the associated affected roads a large flood relief scheme is required given the extent of the flood area and length of exposure to the sea and estuary. Such a Scheme is being investigated as part of the CFRAM Study for the Galway City and Environs Area. Some demountable measures could be considered to protect this area similar to the small section already available for the Spanish Arch area but given the extent of the measures required it may not be the most feasible solution.</p> <p>For these areas affected by flood risk, flood warning and flood and traffic response measures need to be included so that road closures and detours are timely introduced so as to protect well fare of road users, minimise damage and minimise major traffic congestion. Such warnings are currently available during times of predicted storm surge events.</p>

	<p>Should sea level rise achieve the levels predicted, flooding could occur more frequently and to a greater depth which could disrupt the route operation. This will represent a major challenge to the ability to use the Docks area as part of the City Centre Access Network unless a flood relief scheme is introduced.</p> <p>Future new structural development works to the road network within the identified flood risk zones whether they are minor or major development works should have a stage 3 site specific Flood Risk Assessment carried out so as to meet the requirements of the Flood Risk Management Planning Guidelines. This assessment should ensure that such works will not impact on flood risk to the area and that an integrated flood management plan including an evacuation plan are in place.</p>
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#### 4.3.7 Proposed Road Network – The Cross-City Link/Core City Centre Access Routes

**Table 11 SFRA for the Proposed Road Network – The Cross-City Link/Core City Centre Access Routes**

Site Description	The public transport Cross-City Link/Core City Centre Access comprises a Bus Priority/Bus Only and Pedestrian Route from the train and bus stations, past Eyre Square, onwards to Woodquay and over the River Corrib past the Cathedral to join the Newcastle Road (City Centre Access Network) at the University Road and Newcastle Road Junction. The inner city access route for vehicular traffic runs from Lough Atalia Road along Fairgreen Road, Bóthair na mBan to the Headford Road.
Vulnerability Category	Existing road network to be utilised but given its proposed role as the cross city centre public transport route this would be considered to be essential infrastructure and therefore “highly vulnerable development”.
Flooding mechanism	Fluvial flooding from the River Corrib and potentially the Terryland River if its swallow holes become blocked. There may also be potential urban drainage network issues.
Benefitting from Flood defences or Flood relief scheme	The levels in the River Corrib are controlled by the OPW who operate the Salmon Weir Barrage. The River Corrib channel was also deepened as part of the Corrib Arterial drainage scheme in the early 1960’s with the Salmon Weir replacement barrage constructed by the OPW in 1959. The Dyke Road embankment protects the Bodkin Junction, the approach roads to this junction and the Headford Road.
Historical Flooding	There has been no flooding from the River Corrib or the Terryland River since and possibly before the Arterial Drainage Scheme was completed in the 1960s. Historically the Dyke Road embankment has been present since the 1800’s.
Flood Risk	The area in which the public transport Cross-City Link and the Inner City Access Route are located have been modelled in the CFRAM detailed study and predictions for fluvial events from the River Corrib and its canals are available for the 100 year and 1000 year events having a high degree of confidence. The CFRAM study shows

	<p>that a large section of the Headford Road to the Bodkin Junction is within fluvial Flood Zone A but protected by the Dyke Road embankment against the 100 year flood. However this area is shown to be vulnerable to flooding from the 1000 year River Corrib flood event.</p> <p>The Cross City Link has been identified as travelling along existing roads all located in the Low Flood Risk Zone C. The effect of climate change on this route is unlikely to be significant.</p>
Climate Change	<p>The predicted increases in fluvial flood flows of 20 to 30% potential could overtop the Dyke Road embankment as its design standard is the current 100 year event.</p>
Residual Risk	<p>A residual risk exists for the Terryland area in the event of overtopping or breach in the Dyke Road embankment and the mal-functioning of the Salmon Weir Barrage hydraulic gates.</p> <p>A breach of the Salmon Weir Barrage could create a dambreak type residual flood risk to its downstream reach and estuary areas but such a risk is very low given the operation and configuration of the gated weir structure and the slow nature of flooding in the River Corrib.</p>
Development Considerations and Flood Risk Management	<p>The proposed strategy is to utilise the existing road network with traffic flow type upgrades and therefore avoidance of the flood risk areas at the Headford Road is not possible as no suitable alternative routes were available.</p> <p>Furthermore the Headford Road is protected by a maintained OPW Flood Relief Scheme.</p> <p>There is little in the way of mitigation that can be provided in terms of road design. Higher embankment levels for the Dyke Road embankment could be considered in the future if climate change predictions become a reality.</p> <p>For this area flood warning and flood and traffic response measures should be investigated in the event of overtopping of the Dyke Road embankment or blockage to the Terryland swallow hole system.</p>



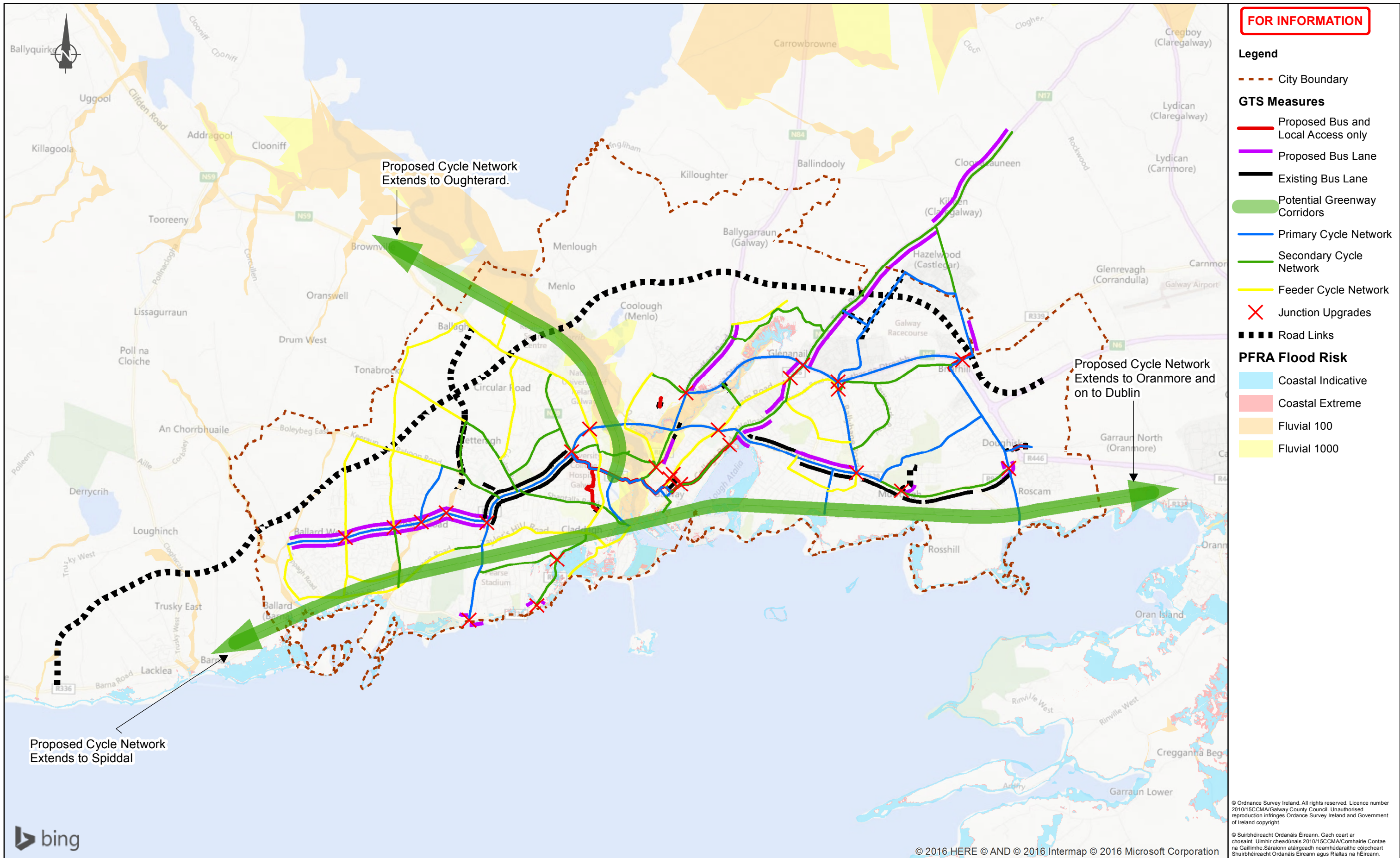
	<p>Future development works to these access routes within the identified Flood Risk Zones whether they are minor or major development works should have a stage 3 site specific Flood Risk Assessment carried out so as to meet the requirements of the Flood Risk Management Planning Guidelines. This assessment should ensure that such works will not impact on flood risk to the area and that an integrated flood management plan including an evacuation plan are designed and put in place in the event of overtopping or breach in the defences.</p>
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#### **4.3.8 Proposed Park & Ride Facilities**

**Table 12 SFRA for the Proposed Park & Ride Facilities**

Site Description	<p>The general area for such Park &amp; Ride facilities has been identified but not the specific sites locations. Potential Park &amp; Ride sites are proposed off the M6, N17 and west of the city centre.</p>
Development Considerations and Flood Risk Management	<p>Given that these are new proposed facilities the siting of these facilities should be located within Flood Zone C with climate change scenarios included.</p>

## Appendix A



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Job Title  
**Galway Transport Strategy**

Scale: **1:50,000**  
Date: **September 2016**

I1	01/09/2016	NOR	MH	EMC
Issue	Date	By	Chkd	Appd

Drawing Title  
GTS Measures with PFRA Flood  
Risk Mapping - Coastal & Fluvial

Drawing Status  
**For Information**

Job No	Drawing No	Issue
<b>233985-17</b>	<b>GCOB-SK-D-677</b>	<b>I1</b>



### Legend

- City Boundary**
- GTS Measures**
- Proposed Bus and Local Access only
  - Proposed Bus Lane
  - Existing Bus Lane
  - Potential Greenway Corridors
  - Primary Cycle Network
  - Secondary Cycle Network
  - Feeder Cycle Network
  - Junction Upgrades
  - Road Links
- PFRA Flood Risk**
- Groundwater
  - Pluvial Indicative
  - Pluvial Extreme

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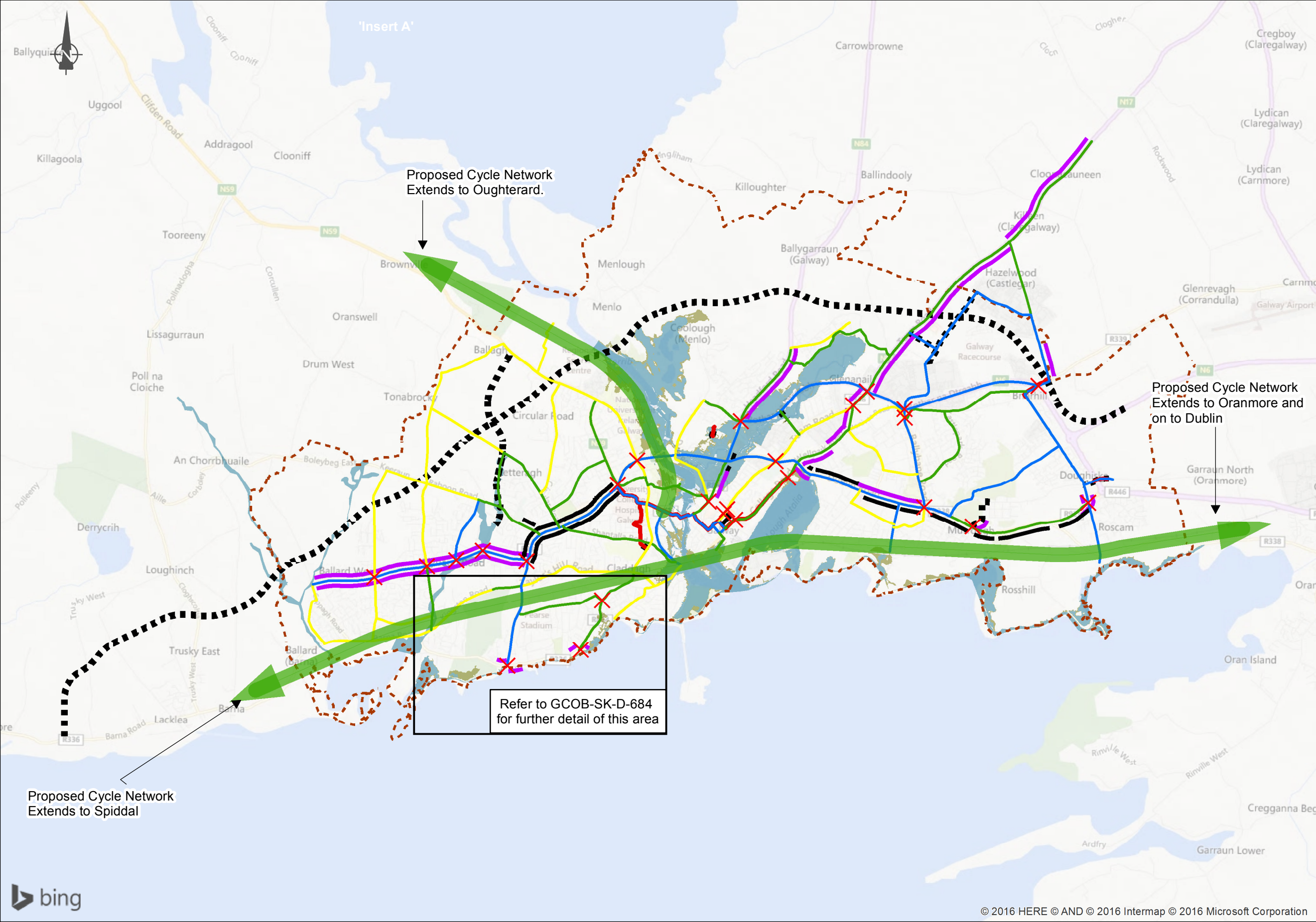
I1	01/09/2016	NOR	MH	EMC
Issue	Date	By	Chkd	Appd

Drawing Title  
**TS Measures with PFRA Flood  
 Risk Mapping - Pluvial & Groundwater**

Drawing Status  
**For Information**

Job No	Drawing No	Issue
33985-17	GCOB-SK-D-678	I1





FOR INFORMATION

Legend

City Boundary

GTS Measures

CFRAM Flood Risk

Proposed Bus and Local Access only

Proposed Bus Lane

Existing Bus Lane

Potential Greenway Corridors

Primary Cycle Network

Secondary Cycle Network

Feeder Cycle Network

Junction Upgrades

Road Links

Flood Zone A

Flood Zone B

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Issue	Date	By	Chkd	Appd

Drawing Title

GTS Measures with CFRAM Flood Risk Mapping - Flood Zones

Drawing Status

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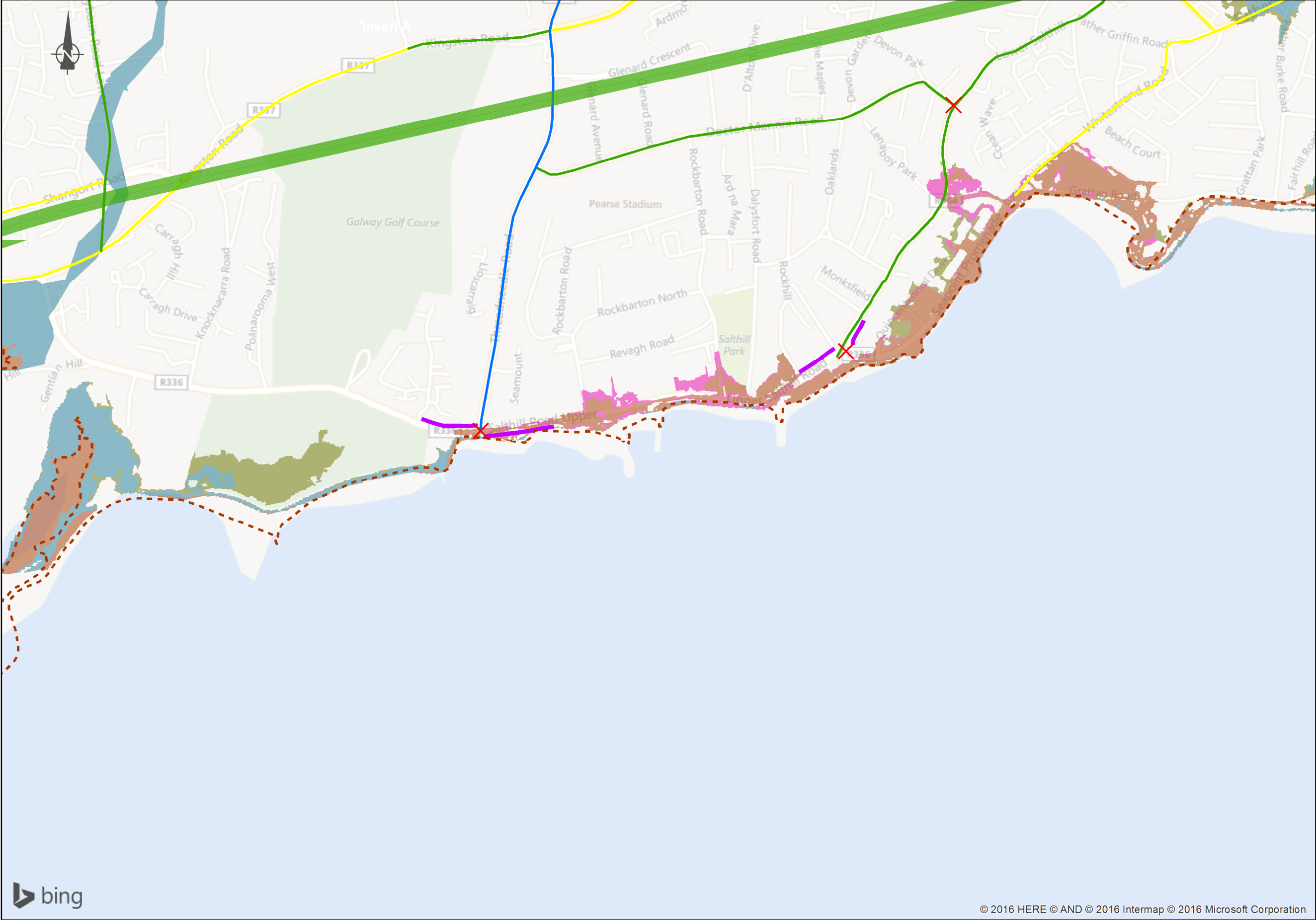
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Issue

233985-17

GCOB-SK-D-683

11



FOR INFORMATION

Legend

- City Boundary
- GTS Measures**
  - Proposed Bus and Local Access only
  - Proposed Bus Lane
  - Existing Bus Lane
  - Potential Greenway Corridors
  - Primary Cycle Network
  - Secondary Cycle Network
  - Feeder Cycle Network
  - Junction Upgrades
  - Road Links
- CFRAM Flood Risk**
  - 0.5% AEP Wave Overtopping
  - 0.1% AEP Wave Overtopping
  - Flood Zone A
  - Flood Zone B

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Date: **September 2016**

Drawing Title  
**GTS Measures Salthill Area with CFRAM Flood Risk Mapping**

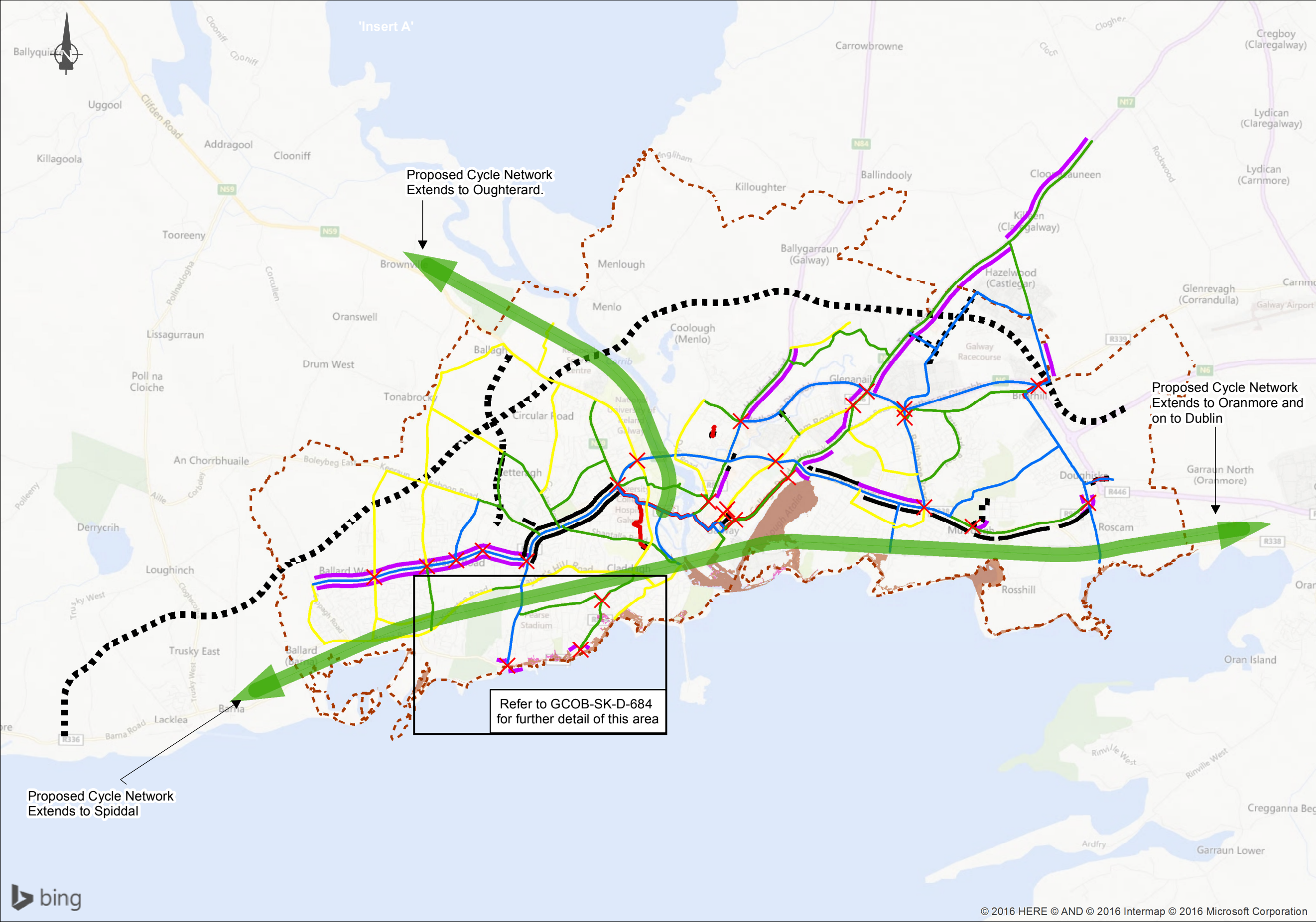
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FOR INFORMATION

Legend
 

- City Boundary
- GTS Measures**
  - Proposed Bus and Local Access only
  - Proposed Bus Lane
  - Existing Bus Lane
  - Potential Greenway Corridors
  - Primary Cycle Network
  - Secondary Cycle Network
  - Feeder Cycle Network
  - Junction Upgrades
  - Road Links
- CFRAM Flood Risk**
  - 0.5% AEP Wave Overtopping
  - 0.1% AEP Wave Overtopping

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Galway Transport Strategy

Scale: 1:50,000  
 Date: September 2016

I1	01/09/2016	NOR	MH	EMC
Issue	Date	By	Chkd	Appd

Drawing Title

GTS Measures with CFRAM Flood Risk Mapping - Wave Overtopping

Drawing Status

For Information

Job No: 233985-17  
 Drawing No: GCOB-SK-D-685  
 Issue: 11